

3rd Edition



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597,218

Convention Date (United States of America): Nov. 7, 1941.

Application Date (In United Kingdom): Aug. 18, 1944; No. 15860/44.

Complete Specification Accepted: Jan. 21, 1948.

(Under Section 6 (1) (a) of the Patents &c. (Emergency) Act, 1939, the proviso to Section 91 (4) of the Patents and Designs Acts, 1907 to 1942 became operative on Feb. 15, 1945).

COMPLETE SPECIFICATION

ERRATUM

SPECIFICATION No. 597,218.

Page 6, line 59, after "oil" insert
"comprises 100 parts by weight of
tung oil or oiticica oil"

THE PATENT OFFICE,
4th May, 1948.

15 THIS INVENTION relates to synthetic resin compositions, more particularly thermo-setting type resin compositions characterised by good electrical insulating properties. Such resinous compositions are further characterised by the fact that they may be applied as impregnating solutions without the use of a solvent which requires 20 evaporation or removal during polymerization.

In the art of applying resinous compositions to members for the purpose of impregnating or coating the members, it 25 has been customary to dissolve the resin in some solvent for the purpose of enabling the application of the resinous composition to the members. As a general rule, the solvents have been low boiling point liquids incapable of entering into reaction 30 with the resin. Consequently, evaporation or removal of the solvents by some means has been practised. In many cases the evaporation of solvents is attended by a 35 deterioration of the physical characteristics of the resin deposited from solution. Gas bubbles, porous pockets, non-uniform filling or impregnation and other undesirable results have followed the 40 evaporation of the solvent.

In a few cases, it is known to employ reacting solvents for resins, these solvents being characterised by the fact that they enter into a polymerizing reaction after 45 impregnation of members with the resin solutions. The reacting solvents for the most part have been employed in dissolv-

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resins in spite of the fact that it would be highly desirable in many instances to 60 obtain a complete resinification of the resin solution. More uniform fill upon impregnation, a more homogeneous and impervious product are some of the advantages to be obtained by employing 65 solutions of resins in which the solvent is subject to a polymerizing reaction. Other advantages accruing from the fact that no evaporable solvent is employed are a saving of time and equipment required for 70 drying purposes.

One object of this invention is to provide a liquid "solventless" resin composition for use in impregnating members.

Another object of the invention is to 75 provide for bonding and insulating electrical and other members by means of a thermosetting resinous composition applied thereto in a solution in which the solvent forms a part of the composition. 80

With the above objects in view, the liquid composition which can be polymerised into an improved thermoset resinous solid, according to the present invention, comprises a solvent composed of from 10 85 to 300 parts by weight of a liquid vinyl or vinylidene monomer and 100 parts by weight of a solute comprising the half ester of castor oil or castor oil derivatives and an unsaturated alpha-beta dicarboxylic 90 acid.

In order that the invention may be more clearly understood and readily carried into effect, reference will now be made to

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COMPLETE SPECIFICATION

Improvements in or relating to Resinous Electrically Insulating Compositions and to Electrical Apparatus Impregnated therewith

We, WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY, of 40, Wall Street, New York 5, State of New York, United States of America, a Corporation organised and existing under the laws of the State of Delaware, in said United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to synthetic resin compositions, more particularly thermosetting type resin compositions characterised by good electrical insulating properties. Such resinous compositions are further characterised by the fact that they may be applied as impregnating solutions without the use of a solvent which requires evaporation or removal during polymerization.

In the art of applying resinous compositions to members for the purpose of impregnating or coating the members, it has been customary to dissolve the resin in some solvent for the purpose of enabling the application of the resinous composition to the members. As a general rule, the solvents have been low boiling point liquids incapable of entering into reaction with the resin. Consequently, evaporation or removal of the solvents by some means has been practised. In many cases the evaporation of solvents is attended by a deterioration of the physical characteristics of the resin deposited from solution. Gas bubbles, porous pockets, non-uniform filling or impregnation and other undesirable results have followed the evaporation of the solvent.

In a few cases, it is known to employ reacting solvents for resins, these solvents being characterised by the fact that they enter into a polymerizing reaction after impregnation of members with the resin solutions. The reacting solvents for the most part have been employed in dissolv-

ing a polymer composed mainly of the solvent itself. For example, a polystyrene has been applied in solutions with monostyrene as the solvent. Upon the application of a catalyst and heat, the monostyrene was polymerized with the polystyrene to produce a resinification of the entire solution.

However, the preparation of these so-called "solventless" resin compositions has not been generally extended to other resins in spite of the fact that it would be highly desirable in many instances to obtain a complete resinification of the resin solution. More uniform fill upon impregnation, a more homogeneous and impervious product are some of the advantages to be obtained by employing solutions of resins in which the solvent is subject to a polymerizing reaction. Other advantages accruing from the fact that no evaporable solvent is employed are a saving of time and equipment required for drying purposes.

One object of this invention is to provide a liquid "solventless" resin composition for use in impregnating members.

Another object of the invention is to provide for bonding and insulating electrical and other members by means of a thermosetting resinous composition applied thereto in a solution in which the solvent forms a part of the composition.

With the above objects in view, the liquid composition which can be polymerised into an improved thermoset resinous solid, according to the present invention, comprises a solvent composed of from 10 to 300 parts by weight of a liquid vinyl or vinylidene monomer and 100 parts by weight of a solute comprising the half ester of castor oil or castor oil derivatives and an unsaturated alpha-beta dicarboxylic acid.

In order that the invention may be more clearly understood and readily carried into effect, reference will now be made to

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the accompanying drawing, in which:—

Figure 1 is a view in elevation of a stack-type magnetic core;

Fig. 2 is a view in elevation of a wound type core;

Fig. 3 is a view partly in section of a wound type core being impregnated;

Fig. 4 is a view partly in section of a heat-treating oven for a wound type core;

Fig. 5 is a view in elevation of a cutting operation; and

Fig. 6 is a greatly enlarged fragmentary cross-sectional view of a bonded core.

According to this invention, a thermosetting synthetic resin is prepared by first dissolving a resinous reaction product in a reacting solvent which is capable of polymerizing in conjunction with the reaction product to produce a solid material. The solution prepared by dissolving the reaction product in the reacting solvent is known as a "solventless" varnish or resin solution. This basic resin solution may be modified with other resinous reaction products capable of polymerizing conjointly therewith in order to impart predetermined toughness, solvent resistance and other desirable characteristics.

For the purpose of this invention, the basic reaction product comprises the reaction product of castor oil or castor-oil derivatives with unsaturated alpha-beta dicarboxylic organic acids. Examples of unsaturated dibasic acid and their equivalent include maleic anhydride. The castor oil and the unsaturated dibasic organic acid may be combined in a wide range of proportions. A satisfactory product is produced by reacting three parts of castor oil and one part of maleic acid. The ingredients upon heating, without a catalyst, at a temperature of for example, 120° C., while stirring will react together sufficiently for the purpose of the invention in two to four hours. It is generally advisable to carry out the reaction in a closed vessel with a condenser to avoid the sublimation of the maleic acid into the atmosphere. The proportions of castor oil to the dibasic acid may be varied from the three-to-one ratio mentioned above. The preferred range of proportions consists of from two to four parts by weight of castor oil to one part of dibasic acid.

Larger quantities of castor oil per unit quantity of dibasic acid may be heated to produce thick viscous oils which, in many cases, produce desirable solid polymers with the reacting solvent upon subsequent treatment.

An example of the preparation of the reaction product was provided by dissolving 100 parts by weight of castor oil with 30 parts by weight of maleic anhydride

and heating for four hours at 120° C. The product had an acid number of 130 to 135. The particular acid number and the mechanical characteristics of the reaction product is dependent on the heat treatment. Thus the reaction could be carried out for 18 hours to cause the dibasic acid and castor oil to polymerize into a substantially rubber-like mass. However, it is not desirable to carry out the reaction to the extent that the material becomes solid.

It is believed that dibasic unsaturated acids form the half ester with castor oil. The other carboxyl group of the dibasic acid is free. As will be pointed out herein, it may be desirable to esterify the latter carboxyl group with an alcohol.

When the reaction of the dibasic acid and the castor oil has reached the desired state of completion, it is cooled to room temperature and from 10 to 300 parts by weight of a vinyl or vinylidene monomer, or in some cases a partially polymerized vinyl compound, such as distyrene, is added per 100 parts of the castor oil dibasic acid reaction product. To prevent the resin from reacting prematurely with the solvent it is desirable to incorporate 0.02% of hydroquinone or other anti-oxidant in order to stabilize the mixture. The vinyl or vinylidene monomer acts as a solvent for the reaction product and produces a solution of a viscosity suitable for impregnating purposes. Vinyl acetate, styrene, methyl methacrylate and other polymerizable vinyl and vinylidene monomers have been successfully used in preparing the solution of solventless resin. The solution may be applied to members after incorporation of a catalyst either in the resin or on the surface of the members being impregnated. After impregnation of the members with the solution they may be subjected to heat in a range of 150° C. to 250° S. and gelling or polymerization will take place in two to three minutes. It is believed the vinyl monomer is cross-coupled by the reaction product to produce a thermostat resin.

A solid copolymer thus prepared by reacting 30 parts by weight of maleic anhydride, 100 parts by weight of castor oil and 24.4 parts by weight of monostyrene was tested for its electrical insulating properties. At 60 cycles, the power factor was 3.08% and the S.I.C. value was 4.83. Considering the fact that the resin is thermosetting in nature, these values are indicative of advantageous electrically insulating features.

A particularly desirable application for the liquid resin composition is in magnetic cores to provide both for a bonding and an insulating layer between the laminations. Transformer laminations of all shapes and

motor and generator magnetic laminations may be successfully bonded together into solid cores having unusual advantages. The cores may be cut or worked to shape and size after bonding without delamination.

One application of the invention may be seen by referring to Fig. 1 of the drawing showing a stack type magnetic core assembly 10 suitable for use in transformers. The core assembly 10 consists of three vertical core legs 12 each composed of a plurality of laminations of magnetic material and four transverse cores 14 each composed of a similar number of laminations of magnetic material. The cores 12 and 14 are prepared by stacking a predetermined number of punched laminations of similar shape. After clamping the stacked laminations in a jig to prevent relative displacement, the solution composed of the reaction product of castor oil and dibasic acid dissolved in a vinyl monomer, such as monostyrene, is applied to the laminations. A catalyst, for example, 0.1% to 2% of benzoyl peroxide, may be added to the resin solution immediately prior to the impregnation. When the core has been thoroughly impregnated with the resin, and all the air between laminations displaced, it may be subjected to heat treatment in the temperature range of 150° C. to 250° C. to cause the resin completely to solidify in a few minutes.

Alternatively, stacked laminations may be immersed in an acetone solution of benzoyl peroxide, or equivalent catalyst, to provide a coating of the solution over all of the surfaces, the cores removed and allowed to drain. The cores are then flash dried in a vacuum or in an oven for a few minutes. This produces a thin layer of benzoyl peroxide over the surfaces of the core laminations. The core may then be placed in an impregnating tank containing the resin solution. The impregnation cycle commonly employed is to apply a vacuum to the impregnation tank for 15 minutes in order to remove the air between laminations, followed by pressure at 80 pounds per square inch for one hour in order thoroughly to force the resin into the innermost portions of the core. Following this the cores may be baked for varying periods of time at temperatures of up to 250° C.

Cores prepared by bonding laminations with the solventless resin compositions, after heat treatment will be found to be completely filled. The bonded cores have been cut and ground and further processed to produce substantially plane surfaces in order that the cores 12 and 14 fit without any appreciable air gap into an assembly 10 in order to achieve maximum electrical

efficiency. The thermosetting resin is solid and impervious to dielectric liquids such, for example, as refined petroleum oil. The impregnation is 100% complete and no voids or unbonded laminations occur as compared to less satisfactory results attained when similar resins are applied by the use of a non-reacting solvent requiring evaporation.

It will be appreciated that the particular magnetic core 10 of Fig. 1 may be impregnated or consolidated with resins by other methods than by applying a resin from solution to the stacked laminations. However, there are magnetic cores being produced in the electrical industry today that can be solidified only with a bonding and insulating composition applied as a solution. An example of such a core is the core 20 illustrated in Fig. 2. The core 20 is produced by winding a single strip of magnetic material 22 continuously to produce a circular or rectangular shaped core with a central window. The core 20 has been developed particularly for the most efficient and economical use of the recently available high permeability silicon irons of the type known under the Registered Trade Mark "Hipersil". The high permeability silicon irons are produced by processing the metal in such a manner as to orient substantially all of the crystals of the metal in a preferred direction so that the axis of easiest magnetization is along the length of the strip 22. Accordingly the losses for a given flux and frequency are lowest and the permeability is highest in the direction of the length of the strip. The core 20 is characterized by high magnetic efficiency because all the magnetic flux passes only along this direction, whereas if the same material were to be employed in preparing the core assembly 10 of Fig. 1, the efficiency would be somewhat reduced.

In order to embody the core 20 in electrical apparatus, it has been found necessary to sever the core into two U-shaped elements 24 and 26 in order to introduce the windings about the legs and through the window of the cores. The faces 28 between the legs of the U should be worked to substantial planeness and a high degree of uniformity in order to make the air gap loss extremely low.

The operation of cutting the wound core 20 into two U members and working the faces requires that the laminations be bonded very durably to one another. The cutting operation may be performed by use of milling cutters and rubber bonded abrasive cutting wheels and similar types of cutting devices. The faces 28 may be additionally subjected to grinding and in some cases to a further etching operation

to remove the finest burrs.

The core 20 will successfully withstand the cutting and working operations required to produce plane faces 28 when the core has been bonded with the resins disclosed in this invention. As illustrative of the method of bonding a wound core reference should be made to Figs. 3 to 5 of the drawing. In Fig. 3 is shown an impregnating tank 30 consisting of a strong walled casing 32 and a tightly fitting cover 34. Means for evacuating air from tank 30 introducing pressure consist of pipe 36. Within the container 30 is the solution 38 of a vinyl monomer and the castor oil-unsaturated dibasic acid half ester. The resin solution 38 may contain approximately 0.1% benzoyl peroxide in order to provide for the polymerization of the resin. Otherwise, the core 20 may be pretreated with a solution of the catalyst and dried as previously described in connection with the core 10. A wound core 20 is placed in the casing 32 and the cover 34 applied and, after evacuation to remove air and other gases between laminations, pressure is applied to the surface of the resin 38 to cause penetration and filling of the spaces. After resin impregnation, the core is removed to the oven 40 shown in Fig. 4.

The oven 40 embodies a closure 42 and a supporting means 44 on which the impregnated cores may be suspended. Heated air may be introduced through inlet 46 and exhausted through outlet 48. It is also feasible to heat the oven by the use of resistance elements disposed about the interior of the oven 40 as is well known. After heat treatment in the temperature range of 150 to 250° C. for a period of time sufficient to cause the resin completely to polymerize, the cores are removed from oven 40 and allowed to cool. The core will be a solidly bonded unit without air pockets.

Reference should be had to Fig. 5 showing the subsequent operations on the resin bonded core 20. The core 20 is sawed into two U-shaped units on the cutting attachment 50 composed of a core holding table 52 and a saw 54. The solidified resin supports the laminations with respect to each other and no great difficulty has been observed in sawing the wound core in two. Grinding and etching may be subsequently employed to improve the core faces 28.

The cut and worked faces 28 of the core 20 are shown in the enlarged fragmentary cross sectional view of Fig. 6. The individual laminations 22 are separated from each other by the layer of resin 60 which functions as the bonding agent. Numerous cores of this type have been produced and

have functioned satisfactorily in service. The scrap due to delamination is extremely small and the bond has functioned to meet all electrically insulating and mechanical requirements.

Durometer measurements of the hardness of the castor oil-maleic anhydride-styrene resins, for example, has disclosed that the resins have an exceptionally flat hardness-temperature curve. The durometer measurements at room temperature, that is 28° C., have given values of 80 and at 100° C., the value is 70. This relative small change of hardness with temperature is particularly important for many applications.

The resin prepared from castor oil, an unsaturated dibasic acid and a vinyl monomer, has been satisfactory when in contact with refined petroleum oil. Such refined petroleum oil is a common liquid dielectric in electrical apparatus. In cases where the magnetic cores or other members are to be employed in contact with more active dielectrics, for example, the halogenated hydrocarbons, the resin should be somewhat modified to contribute increased resistance to the solvent action of these latter dielectrics.

Additions conferring increased solvent resistance are prepared by condensing a polyhydric alcohol with a dibasic acid, part of which may be an unsaturated dibasic acid; preferably the material is prepared by reacting approximately equimolar quantities of polyhydric alcohol and dibasic acid.

A satisfactory proportion for some purposes is two-thirds mol adipic acid, 1 mol maleic anhydride and 1-2/3 mols propylene glycol. Condensation or reaction is effected by heating the mixture of polyhydric alcohol and dibasic acid for two hours at 200° C. to produce an amber coloured resin. Another combination was prepared by reacting 75 parts by weight of adipic acid, 75 parts maleic anhydride and 135.4 parts diethylene glycol. This was reacted to a viscous resin and dissolved in 25% of its weight of monostyrene.

The resin produced by condensing the polyhydric alcohol with the dibasic acid may be put in solution by employing a vinyl monomer, for example, monostyrene. In the specific example given above, the amount of monostyrene produced a solution of a viscosity suitable for addition to the castor oil-maleate-styrene solution. The polyhydric alcohol-dibasic acid resin is most compatible with the castor oil-maleic anhydride produce when about 50% of the dibasic acid has from 6 to 10 carbon atoms in the aliphatic chain.

The solutions may be admixed in substantially equal parts, that is, 100 parts of 180

the castor oil-maleic anhydric and monostyrene composition and 100 parts of the polyhydric alcohol-dibasic acid and monostyrene composition are combined to produce a mixture which when polymerized exhibits a high degree of resistance to the solvent action of chlorinated hydrocarbons. As little as 20 parts of the polyhydric alcohol and dibasic organic acid may be added to the basic solution in order to confer improved resistance to the solvent action of various dielectrics. From 20 to 330 parts of vinyl monomer such as monostyrene are required to dissolve a mixture composed of 100 parts each of the castor oil-maleate and the polyhydric alcohol-dibasic acid reaction product.

In tests made on magnetic cores, particularly cores embodying preferentially oriented silicon steel, it has been discovered that the magnetic steel is susceptible to strains such as may be set up when an impregnating resin hardens. For example, the losses of an unimpregnated wound core for a given flux density and frequency may be approximately 10% lower than the losses for the same core impregnated with the castor oil-maleic anhydride-monostyrene copolymer.

It is believed that the polymerization of this three component resin introduces strains into the laminations of magnetic material and thus causes increased losses.

In order to reduce the losses in magnetic materials sensitive to strains produced by the polymerization of the resin impregnant, the castor oil-maleic anhydride-styrene composition may be modified to produce a tougher resin which when applied to laminations of magnetic material results in lower losses. A suitable modifying resin addition is produced by reacting tung oil or oiticica oil with an unsaturated dicarboxylic acid. The dibasic acid, for example, maleic anhydride may be reacted with tung oil at temperatures from 150 to 200° C. for a period of several hours. A thick viscous liquid is generally produced by the reaction. The tung oil-unsaturated dibasic acid product may be added in quantities ranging from 2 to 4 times the amount of castor oil-dibasic acid-vinyl monomer in order to produce a satisfactory low loss resinous binder. The losses in cores impregnated with a mixture comprising 100 parts by weight of castor oil-maleate, 30 parts by weight of styrene and 390 parts by weight of tung oil-maleate have been reduced to one-fourth of the loss increase when the castor oil-maleate dissolved in styrene is employed alone as the core bonding agent.

The tung oil-dibasic acid additions to the castor oil reaction product produces resins which are much tougher as well as

slightly softer than the castor oil-dibasic acid resins alone.

A further characteristic of the castor oil-unsaturated dicarboxylic acid-styrene compositions has been their sound and noise absorbing properties. A core prepared with these resins as shown in Figs. 3 to 5, gives a substantially dead sound similar to a piece of lead when struck with a hammer. Thermoplastic resins, for example, when applied to the wound cores in a solvent which requires evaporation and baked hard to produce good electrical insulation and high degree of bonding will ring like a bell. The latter core when employed will be noisier due to magnetostriction than the former core which will tend to absorb magnetostrictive noises and act like a damped mechanical system. The castor oil-dibasic acid thermosetting resin alone or modified as indicated above will greatly diminish the noisiness of the cores. Resonance will be impossible as may occur with the cores produced with known thermoplastic resins.

In preparing solutions of the castor oil-dibasic acid thermosetting resin, the tung oil-dibasic acid and the polyhydric-alcohol-dibasic acid reaction dibasic products may be simultaneously embodied in the composition in order to achieve high solvent resistance as well as a high degree of toughness.

Furthermore, since the castor oil and the dibasic acids usually form only half esters, thus leaving one carboxyl group free whereby the resin is acid in nature, it may be desirable to esterify the free carboxyl group. For example, methyl groups and other aliphatic hydrocarbon groups may be attached to the free carboxyl group by esterification with an appropriate alcohol and thereby convert the resin to a neutral material. It will be appreciated that the fully esterified dibasic acid-castor oil product polymerizes more slowly with styrene for example than the product with the free carboxyl group and due allowance should be made for this in polymerization.

The solventless compositions disclosed in this invention may be employed for other purposes than impregnating magnetic cores. Materials and members of all types may be bonded therewith—mica flakes, glass cloth, paper, may for example be combined to produce laminated composites.

A particularly advantageous use of the resin is the application of the composition to small transformers, such as instrument transformers and the like for imbedding and insulating the core and windings. previously, tar, pitch and other materials have been made use of in filling small

transformers of this kind. It has been discovered, however, that the resin composition disclosed herein has certain advantageous properties for this purpose for example as lack of leakage. An economical method of employing the resin composition as a filler for such electrical apparatus is to incorporate an inorganic filler up to 60% of the weight of the resin. Examples of suitable fillers are clean quartz, sand, feldspar and ceramic particles. One method which has been found satisfactory in incorporating the inorganic filler is to coat the inorganic filler with a polymerizing catalyst, such as benzoyl peroxide so as to produce a film thereof on the surface of the inorganic particles. When it is desired to fill the casing of the apparatus, the liquid composition is poured in first and the catalyst coated sand and the like mixed in slowly until the casing is full. The apparatus is then placed in an oven and heated for a period of time sufficient to cause the resin completely to solidify.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A liquid composition comprising a solvent composed of from 10 to 300 parts by weight of a liquid vinyl or vinylidene monomer and 100 parts by weight of a solute comprising the half ester of castor oil or castor oil derivatives and an unsaturated alpha-beta dicarboxylic acid.

2. A liquid composition as claimed in Claim 1, wherein the remaining carboxyl is esterified with an aliphatic hydrocarbon alcohol.

3. A liquid composition comprising 300 to 400 parts by weight of the reaction product of tung oil or oiticica oil and an unsaturated alpha-beta dicarboxylic acid, 100 parts by weight of the reaction product of from 2 to 4 parts by weight of castor oil or castor oil derivatives and 1 part by weight of an unsaturated alpha-beta dicarboxylic acid and 10 to 300 parts by weight of a vinyl monomer to provide a reacting solvent for the reaction products.

4. A liquid composition as claimed in Claim 1 or 3, wherein said vinyl monomer comprises monostyrene.

5. A liquid composition as claimed in Claim 3 or 4, wherein the said reaction product including the tung or oiticica oil and from 20 to 25 parts by weight of an unsaturated alpha-beta dicarboxylic acid.

6. A liquid composition as claimed in Claim 1 or 3, including up to 100 parts by weight of the reaction product of a polyhydric alcohol, an unsaturated di-

basic acid, and a saturated dibasic organic acid having from 6 to 10 carbon atoms in the aliphatic chain and including an additional amount of from 10 to 30 parts of the solvent liquid vinyl monomer.

7. A liquid composition as claimed in Claim 3 or 4, wherein the said reaction product including the tung or oiticica oil comprises 100 parts by weight of tung or oiticica oil and from 20 to 50 parts by weight of an unsaturated alpha-beta dicarboxylic acid to provide for toughness and from 20 to 100 parts by weight of the reaction product of substantially equimolar quantities of a polyhydric alcohol and dicarboxylic acids to provide for resistance to the solvent action of fluid dielectrics, at least 50% of the dicarboxylic acids having from 6 to 10 carbon atoms in the aliphatic chain and including an additional amount of from 10 to 30 parts of the reacting solvent vinyl monomer.

8. The method of bonding a plurality of laminations of magnetic material with a thermoset resinous insulating composition to produce a solid and impervious magnetic core which comprises applying to the stacked laminations a liquid composition as claimed in any of the preceding claims, and heat treating the impregnated laminations under conditions to cause copolymerisation of substantially all of the solution.

9. The method as claimed in Claim 8, including the preliminary step of applying to the stacked laminations a dilute acetone solution of benzoyl peroxide or equivalent dilute liquid polymerising catalyst, and drying the laminations to provide a thin film of catalyst on the surfaces of the laminations.

10. The method of applying insulation to electrical apparatus including a plurality of conductors which comprises applying to the apparatus the liquid composition as claimed in any of the preceding Claims 1 to 7, inclusive and subsequently polymerizing the said liquid composition by heat.

11. A magnetic core comprising a plurality of laminations and a resinous binder applied to the laminations electrically to insulate the laminations and to bond the laminations into a substantially solid core the said resinous binder being constituted by the polymerized product of the liquid composition as claimed in any of the preceding Claims 1 to 7, inclusive.

12. Insulated electrical apparatus including a plurality of electric conductors having insulation applied thereto, wherein said insulation is composed of the liquid composition as claimed in any of the preceding Claims 1 to 7, inclusive,

polymerised by heat.

13. Apparatus as claimed in Claim 12, wherein the said insulation includes a finely divided inorganic filler material.

5 14. A liquid composition which can be polymerised into a thermoset resinous solid of good electrical insulating value, substantially as hereinbefore described.

15 15. The method of bonding a plurality of laminations of magnetic material with a resinous insulating composition to produce a solid and impervious magnetic core, substantially as hereinbefore described with reference to the accompanying drawings.

16. The process of applying insulation to electrical apparatus, substantially as hereinbefore described with reference to the accompanying drawings.

17. Electrical apparatus insulated with the resinous insulating composition, substantially as hereinbefore described with reference to the accompanying drawings. 20

Dated this Seventeenth day of August, 1944.

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Fig. 1.

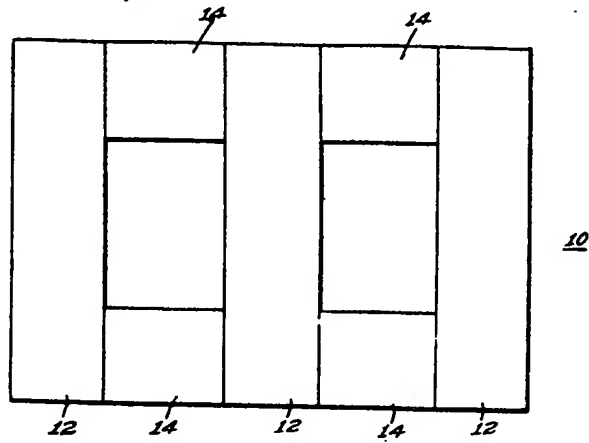


Fig. 2.

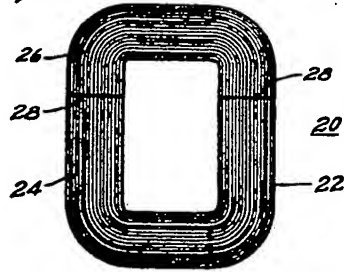


Fig. 3.

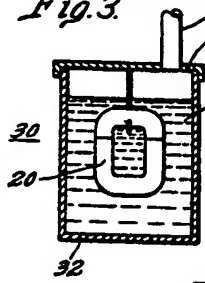


Fig. 4.

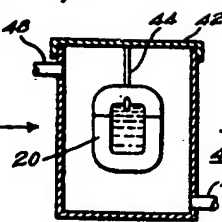


Fig. 5.

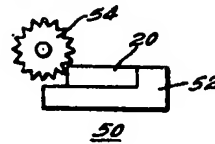
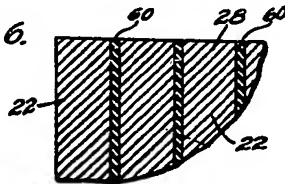


Fig. 6.



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